Saskatchewan

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## Agriculture Development Fund

## FINAL REPORT

**PRODUCTION OF NATIVE FRUITS, MEDICINAL AND ORNAMENTAL PLANTS IN NORTHERN SASKATCHEWAN**

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# Production of fruits, medicinal and ornamental plants in northern Saskatchewan

ADF Project # 96000069

Final Report

March, 2001

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## Executive Summary

It should be noted that the results summarized here do not include the other crops also grown on the Potato Lake site: 8 cultivars of strawberry crowns including U.S. and Canadian-sourced, 6 garlic selections, 6 medicinal and aromatic plant selections. The results of these studies are found in their respective ADF reports and should be consulted. The $10,000 funding per year for this project was not sufficient to cover travel, equipment (water pump was replaced twice [total $4,000]; new heavy-duty rototiller [$2,200]), supplies, personnel, quality analysis costs, shipping to the U.S.A., etc. of these particular crops. Deteriorating equipment at the site resulted in inefficient methods of weed control, irrigation, etc. Significant time was devoted to repair and maintenance of the site. An extra person was hired as labour to assist in weed control. However, the field crew had to be brought up to La Ronge to catch up on the maintenance in mid season. Without a functional tractor at the Potato Lake site, the tractor from the U of S horticulture plots was transported up and back at major expense. Thus, funding from this grant and the other grants were combined to subsidize this project for those above crops. The amount of work on those crops not reported in this final document was quite significant. For example, in 1998, twenty-four thousand strawberry crowns were grown, processed and shipped to California from the Potato Lake location. However, to avoid duplication of reporting results, the author decided to refer the reviewer to the other projects rather than including them here: ADF # 98000073 (Medicinal and aromatic crops) and AFIF #97000353 (Strawberry crowns and garlic).

Several Vaccinium angustifolium (Nova Scotia wild blueberries) show promise. Average berry fresh weight was over double that of the same species grown in Nova Scotia. Furthermore, acidity was lower than berries from Nova Scotia-grown plants. Additional work is required on propagation methods for this crop. Promising medicinal and aromatic crops include fireweed, Labrador Tea, Wild mint, and sweetgrass. These crops self-seed and easily spread from one year to the next. Crops such as goldenseal and bloodroot had consistently low vigour and winter survival was poor.

A small test on strawberry crown production indicates that mother crowns should be left in the ground overwinter for 26% greater daughter production the following year.

## Introduction

Wildcrafting and use of native plant material is currently estimated to be a quarter of a million dollar industry in the north with an estimated potential demand of $2 million/year (Ivanochko, personal communication). Economic opportunities such as wildcrafting and native fruit crops are currently being promoted in northern Saskatchewan. As demand for these materials increase, cultivated production of these plants becomes particularly important for environmental sustainability. However, little information is available on the practical cultivation and production of these plants under northern conditions. Furthermore, potential exists for enhanced chemical activity in northern-grown medicinal plants. For example, ongoing Northern Vigour studies indicate essential oil content of northern-grown garlic to be double that of the same garlic

grown in California. The Potato Lake Research site provides a well established location to conduct research into cultivated production. The site has a wide range of soil textures, pH levels and soil fertility. Some areas are quite acidic (pH 4.5) which permits cultivation of acid-loving plants. These variations are well documented and mapped in detail over this location.

**Plant List and Site Selection**
In collaboration with Gerry Ivanochko and Dr. Branka Barl, the following revised list of plant material was recommended:

**a) Native Fruit and wild edibles**
Vaccinium angustifolium (Nova Scotia wild blueberry)
Vaccinium myrtilloides (Saskatchewan wild blueberry)
Vaccinium vitis-idaea (lingonberries)
Rubus chamaemorus (cloudberries)
Matteuccia struthiopteris (fiddlehead fern)

**b) Medicinal plants**

Ledum groenlandicum (Labrador tea)
Arctostaphylos uva-ursi (bearberry)
Acorus calamus (calamus root)
Mentha arvensis (wild mint)
Hierochloe odorata (sweet grass)
Artemisia sp. (sage)
Eleutherocosus senticosus (Siberian ginseng)
Hydrastis canadensis (goldenseal)
Sanguinaria canadensis (bloodroot)

In addition, twenty-four American ginseng and five Siberian ginseng (*Eleutherococcus senticosus*) were planted.

Note: for the results on the following plants, please consult ADF projects:
Tanacetum parthenium (feverfew)
Silybum marianum (milk thistle)
Calendula officinalis (calendula)
Salvia sclarea (care sage)
Nepeta cataria (catnip)
Echinacea sp. (purple cone-flower species)
Valerian officinalis (valerian)
*Angelica polymorpha sinensis*, (Chinese angelica)
*Arctium lappa* (burdock)

PH and soil type were quite variable in the site but had been previously marked (Figs. I and J).

Plants were rated according to the data sheet (Table A) where applicable.

Fig. I

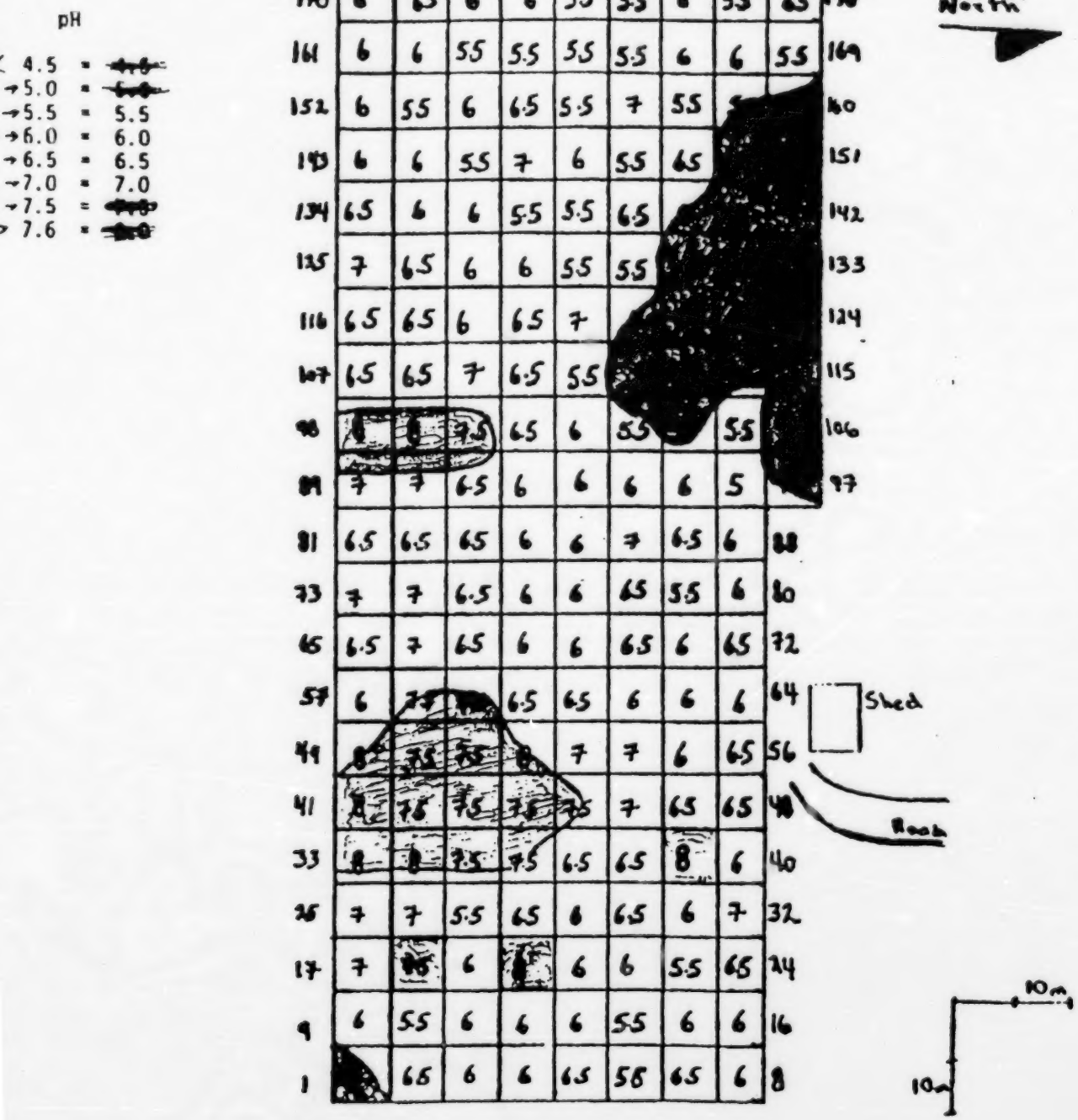

Fig. J

TEXTURE

Code:

S = Sand
LS = Loamy Sand
SL = Sandy Loam
L = Loam
CL = Clay Loam
C = Clay
LC = Loamy Clay
O = Organic

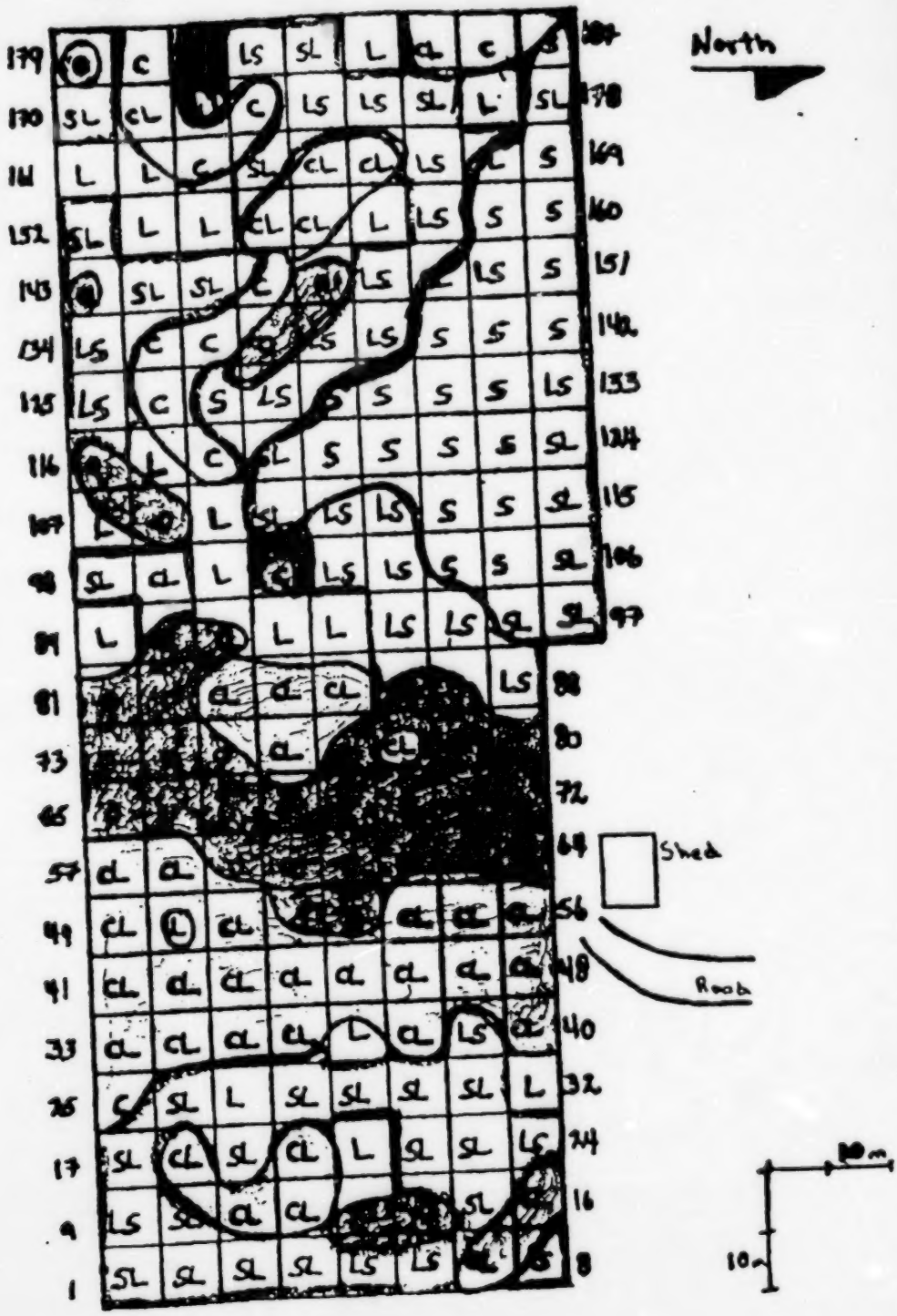

Table A. Data sheet for medicinal and native plants

| Crop | Rep | Stand establishment | Plant # | Date of 1st flower | Vigour rating (0 = poor, 1= good) | Initial Plant height | Final Plant height | Winter survival (0=dead; 1=injured; 2=no inj.) | Overall rating 0=poor; 1=good; 2=excel. |
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## Methodology and Results

Table B. Blueberry samples, quality analysis (1997)

| Sample | Fresh weight (g/berry) | Total soluble solids (%) | Soluble solids (°Brix) | pH | % Titratable acidity (as citric acid) | Sugar to acid ratio |
|---|---|---|---|---|---|---|
| V. myrtilloides | 0.32 | 17.2 | 12.0 | 2.77 | 0.88 | 13.6 |
| 1 | 0.76 | 14.3 | 11.0 | 3.55 | 0.20 | 55.0 |
| 2 | 0.82 | 12.5 | 8.4 | 3.62 | 0.19 | 44.0 |
| 3 | 0.67 | 14.2 | 11.8 | 3.43 | 0.33 | 35.7 |
| 4 | 0.86 | - | 13.0 | 3.45 | - | - |
| 5 | 0.69 | 15.2 | 10.0 | 4.18 | 0.17 | 58.8 |
| 6 | 0.66 | 14.1 | 10.2 | 3.33 | 0.31 | 32.9 |
| 7 | 0.75 | 14.4 | 11.0 | 3.14 | 0.33 | 33.3 |

- = insufficient sample to complete the analysis

The blueberries were analyzed by the Native Fruit Development Program. The blueberries received for analysis were judged to be in good physical condition with no visible mold growth. Most berries in the sample were intact. However, the berries were slightly to moderately soft. This may be due to any of these factors: the berries were overripe when harvested; continued respiration due to lack of removal of the field heat after picking. Refridgeration after harvesting was not provided during shipment to the university and thus the berries may have softened.

Berry fresh weight ranged from 0.32 to 0.86 g/berry. All samples labeled 1- 7 were larger than the named species Vaccinium myrtilloides (Saskatchewan wild blueberry). Fruit sample #4 had the largest berries, but the lowest yield and analysis was limited due to the small amount of fruit received. The V. myrtilloides sample has the lowest pH and the highest titratable acidity at 0.88% (reported as citric acid). The sugar to acid ratio was 13.6. This ratio is considered to be an indication of storage quality of harvested berries, with that fruit which has a sugar to titratable acidity ratio of less than 18 being considered acceptable for distribution. All other samples had sugar to titratable acidity ratios considerably higher than this value. These samples may have been harvested at the overripe stage rather than the ripe stage. It has been reported in the literature that titratable acidity decreases once berries have passed the ripe stage (Kalt and McDonald, 1996).

Kalt and McDonald (1996) harvested blueberry fruit from 3 cultivars over two years and harvested at three ripeness stages: under-ripe (blue fruit with red coloration at the stem end); ripe (entirely blue fruit that was able to pass through a 10 mm screen), and over-ripe fruit (entirely blue fruit and not able to pass through a 10 mm screen). Utilizing this method, they were able to sort the fruit into 3 maturity stages and test the differences in the variables at each stage. Their findings indicated that maturity affected fruit fresh weight, firmness, soluble solids, and titratable acidity. In future, it would be desirable to harvest the crop at the appropriate stage (ripe).

These blueberry selections were then propagated according to Carter and St-Pierre (1996) [Growing blueberries in Saskatchewan, Native Fruit Development Program] with cuttings taken in June and propagated under mist. However, few cuttings rooted and on average, only three plants per selection grew in the greenhouse. Softwood cuttings from these plants were continuously sampled for mistbed propagation with the addition of 100 mg IBA solution prepared by mixing 100 mg IBA in 100 ml of 50% ethanol. Additional field samples were taken and placed under moist 4C conditions to satisfy the chilling requirement and micropropagated 3 months later. The following media was prepared (Table C).

The blueberry micro-propagation became part of a high school instruction program for one student, Kyla Leray. Because of the high degree of internal bacterial and fungal contamination that is unable to be removed through surface sterilization (15% sodium hypochlorite and 1% mercuric chloride solution), the blueberries were unfortunately unable to be micropropagated at this time. Although greenhouse tissue was used, contamination still occurred.

In 1998, eight new blueberry plant selections were made and denoted A to H (Table D, Figs. A-H). These were all Vaccinium angustifolium (Nova Scotia wild blueberry). Criteria for plant selection was based on yield, berry size, uniform ripeness, and relative degree of vegetative propagation (degree of rhizomatous growth). Berries were harvested at the ripe stage, field heat removed and stored at 2°C. Plant selection F had the highest fresh weight yield by over double of some other selections (Table D, Fig. 1). This was due to its aggressive spreading nature of the plant creating a large plant sample. However, individual berry weight and size were small. Selection E had the highest per berry weight (20 berry weight) and size. Moreover, it also had a bloom which may be more appealing to consumers. However, it expressed less even maturity

with about 5% of the berries unripe. While the total yield was half that of F, this was due to its non-spreading nature. In a commercial situation, greater number of plants per acre would be required in order to increase yields compared to F. Another promising selection is G with large berries, higher average 20 berry weight, diameter and yield (Table D, Fig. 1). Bloom is also present. However, it has the highest mean percent water content (Fig. 3). Plant selection B is also recommended with high mean fresh weight, dry weight, lower water content than G (Fig. 1 – 3) and moderately large diameter (Table D). Unfortunately, colour is without bloom and overall non-spreading habit renders its yield lower than other selections (Table D). Thus, higher density plantings may be required. These 4 selection (B, E, F, and G) were further examined in 2000 (Figs. 9 – 11). Selection E again had the highest 20 berry weight as in 1999. Selections B, F, and H had similar 20 berry weights and dry weights (Figs. 9, 10). Selection E had the highest dry weight in both 1999 (Fig. 2) and 2000 (Fig. 10). Mean percent water content was not different for E and F between 1999 and 2000 and remained around 84% (Figs. 3, 11). Similarly, mean percent water content of H remained high at 88% in 1999 (Fig. 3) and 89% in 2000 (Fig. 11). However, mean percent water content for selection B increased in 2000 from 85.5% to 89.5%. Rainfall in the La Ronge region was higher in 2000 than in 1999. Mean temperatures were also lower in 2000 (AFIF # 97000353). Notably, the Saskatchewan-grown V. angustifolium (Nova Scotia) selections all expressed a higher 20 berry fresh weight than those cultivars of V. angustifolium reported by Kalt and McDonald (1996). The Nova Scotia-grown cultivars had a mean 20 berry fresh weight (ripe) stage of 6.62 g. while the Saskatchewan-grown selections had a mean 20 berry weight of 14.75 g in 1999 and 13.75 g in 2000.

Mean pH were similar for all eight selections and were consistent between 1999 and 2000 (Figs. 4, 12). Mean pH ranged between 3 and 4 but were not significantly different. Mean Brix in 1999 was slightly higher (14.4) than in 2000 (13.2)(Figs. 5 and 13). This may be a result of the higher rainfall and lower photosynthetically active radiation due to the cloudy weather. However, Brix levels were not significantly different between the eight plant selections for either year. While colour values were taken for both 1999 and 2000 (Figs. 6 – 8 and 14 – 16), only frozen/thawed samples were available at the time and thus, this measurement should be re-taken on fresh samples. The freeze-thaw process will significantly alter the colour of the fruit.

Table C. Blueberry micropropagation media

| | **mg/litre** |
|---|---|
| $NH_4NO_3$ | 160 |
| $KO_3$ | 202 |
| $MgSO_4$-$7H_2O$ | 370 |
| $KH_2PO_4$ | 408 |
| $Ca(NO_3)$-$4H_2O$ | 708 |
| $FeSO_4$-$7H_2O$ | 55.7 |
| $Na_2EDTA$ | 74.4 |
| MS Minor salts | 32.8 |
| Inositol | 100 |
| Thiamine HCl | 0.4 |

| | |
|---|---|
| Adenine sulfate | 80 |
| IAA | 4.0 |
| Sucrose | 30,000 |
| Agar | 5,500 |
| pH | 4.8 |

Table D. 1999 Blueberry selections (August, 1999 harvest at the ripe stage)

| Plant selection I.D. letter | Total yield (g fresh weight) | Mean 20 berry weight | Mean Diameter (mm) | Diameter range (mm) | Relative colour | Comments |
|---|---|---|---|---|---|---|
| A | 1740.6 | 13.9 | 8.5 | 5 - 11 | Dark blue | Variable size |
| B | 1233.6 | 16.1 | 8.7 | 6 - 12 | Dark blue | |
| C | 1185.4 | 12.2 | 7.3 | 5.5 - 9 | Dark blue | |
| D | 1213.8 | 12.0 | 7.1 | 4 - 9 | Dark blue | |
| E | 1001.2 | 22.1 | 9.3 | 6.5 - 12 | Bloom | Many unripe berries (5%) |
| F | 2198.4 | 12.9 | 7.2 | 4 - 10 | Bloom | 2.5% unripe berries |
| G | 1470.5 | 16.2 | 8.1 | 6 - 10 | Bloom | |
| H | 1061 | 12.6 | 6.9 | 5 - 9 | Bloom | |

Note: plants were selected on the basis of: yield, berry size, uniform ripeness, and relative degree of vegetative propagation.

**Rubus chamaemorus (cloudberries)**

Dr. Harry Jan Swartz, University of Maryland, College Park, MD was contacted (see attached information). He supported the concept of growing cloudberries in Saskatchewan and was willing to send plant material. He suggested that Kristine Ness should be contacted and that we plant the more vigorous cloudberry x blackberry cross. An attempt was made to contact her but she had since moved. However, future projects might again try this crop.

**Matteuccia struthiopteris (fiddlehead fern)**

Faxes and e-mails to New Brunswick could not obtain a response and unfortunately, a suitable plant source could not be located.

## b) Medicinal Plants

The following plants were rated in terms of: mean stand establishment, date of first flowering (where applicable), mean initial plant height (cm), mean final height (cm), overall rating (0 = poor, 1 = good). Fireweed, Labrador Tea (Ledum groenlandicum), Wild Mint (Mentha arvensis), Goldenseal (Hydrastis canadensis), Sweetgrass (Heirochloe odorata), Bloodroot (Sanguinaria canadensis). A minimum of eight plants per rep, with four reps were planted.

Plants were grown in pH 5.5 – 6.5 on loam to sandy loam soil. Shade-requiring plants such as goldenseal and bloodroot were grown under black shade cloth at 50% light penetration. Except for goldenseal and bloodroot, all other plants had an average of 80% plant establishment (Table 4). Wild mint and sweetgrass show good potential with the highest overall rating of 1.0 and a final growth of 4 and 4.7 times initial planting height, respectively.

**Siberian ginseng (Eleutherococcus senticosus)**

Ginseng was acquired, stratified for 9 months but did not germinate. A research project at PFRA (John Kort) examined the low temperature tolerance of American ginseng and storability of this plant. After the completion of that study at PFRA, plants (1 and 2 year old) were transplanted at Potato lake.

Table 4. Mean stand establishment, date of flowering, plant height and vigour rating for six crops of potential medicinal and aromatic value, Potato lake site, 1997.

| Crop | Date of Planting | Mean stand establishment | Date of 1st Flower (where applicable) | Mean initial plant height (cm) | Mean final plant height (cm) | Overall vigour rating, 0=poor; 1=good |
|---|---|---|---|---|---|---|
| Fireweed | June 16 | 81% | July 13 | 12.3 | 44.5 | 0.75 |
| Labrador Tea | June 11 | 79% | | 9.75 with 3 shoots/plant | 20.7 | 0.5 |
| Wild mint | June 12 | 83% | July 13 | 10.1 | 40.8 | 1.0 |
| Goldenseal | June 19 | 0% | | 4.75 with 2 stems per plant | Dead | 0.0 |
| Sweetgrass | June 9 | 80% | | 8.6 | 40.5 | 1.0 |
| Bloodroot | June 19 | 0% | | 12.5 with 2 stems/plant | dead | 0.0 |

In 1998, four of the six species rated showed promise for further testing (Table 5). These include: Labrador Tea, Wild Mint, Sweetgrass and Fireweed. One and two year old American ginseng roots were planted under shade in 1998 but did not grow well. However, Siberian ginseng plantings will be expanded. While all crops expressed good stand establishment, all crops also had varying degrees of winter injury. It is also useful to note that propagation of certain promising crops (fireweed, wild mint and sweetgrass) appears to be best performed by digging up the volunteer seedlings and re-planting. Propagation rate is species-specific but ranges from 10 to 140 times per plant. In 1999, Labrador Tea, Wild Mint, Sweetgrass and Fireweed again showed superior growth compared to the other plants (Table 7). Both Labrador Tea and Sweetgrass flowered within a week of the 1999 and 2000 values.

Additional information was collected on fireweed in 1998 (see below). Yield of fireweed was on average 0.403 kg/m$^2$. Yield was consistent between rows with little or no variation.

**Fireweed Harvest - Potato Lake**

- fireweed was harvested on July 16th and 25th, 1998 at the time of flowering.
-an area measuring $7m^2$ (Rows 1&2) was harvested on July 16th
    -fireweed was harvested to ground level
    -wet weight was 13.80kg
    -sample was air-dried
    -air-dried weight was $2.82kg=0.40kg/m^2$
    -moisture content 80%

-two more rows were harvested on July 25th
    -Row #3 was an area of $4.5m^2$, the fireweed was cut at a height of 20cm
    -wet weight was 7.755kg
    -air-dried weight was $1.855kg=0.41kg/m^2$
    -moisture content 76%

    -Row #4 was an area of $4.5m^2$, the fireweed was cut to ground level
    -wet weight was 7.600kg
    -air-dried weight was $1.795kg=0.40kg/m^2$
    -moisture content 76%
-fireweed was harvested at two levels (20cm and ground level) to determine how regeneration is affected by harvest height. In 1999, data was collected to determine if there was an effect (Table 6). No difference was apparent among any of the treatments (Table 6).

Table 5. 1998 Crop results

| Crop | Plant # | Date of Planting | Stand Establish-ment | Date of flower-ing in 1998 | Plant Height (cm) | Winter Survival # Plants 0 = dead, 1 = injured, 2 = no injury | | | Overall Rating; Potential Crop Value: 0 = poor, 1 = good, 2 = superior |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 0 | 1 | 2 | |
| Labrador Tea | 36 | June 11, 1997 | 100% | May 23 | 20-30 cm (June 22) | 14 | 2 | 23 | 1 |
| Blood Root | 8 | June 19, 1997 | 90% | N/A | 8 – 15 cm (June 22, 1998), 4 – 6 stems per plant | 2 | 4 | 2 | .5 |
| Goldenseal | 24 | June 19, 1997 | 90% but 50% of plants weak | N/A | 10 cm (June 22, 1998), 4 stems per plant | 1 | 11 | 12 | .5 |
| Fireweed* | 16 | June 16, 1997 | 75% | June 22, 1998 | 30–60 cm (June 22, 1998) | 5 | | 11 | 1 |
| Wild mint** | 24 | June 12, 1997 | 100% | N/A | 20-30 cm (June 22, 1998) | 6 | | 18 | 1 |
| Sweetgrass *** | 9 | June 9, 1997 | 90% | N/A | 30 cm (June 22, 1998) | 1 | | 8 | 1 |

* Fireweed: this plant self-seeds such that each plant averaged a propagation rate of 25X (i.e. each plant increased the number of seedlings in 1998 to 25).

** Wild mint: this plant also self-seeds such that each plant produced 140 new seedlings in the second year (1998).

*** Sweetgrass self-seeded and increased 10 new seedlings per plant.

Table 6. 1999 Fireweed Biomass Fresh weight (FW) and Dry weight (DW) harvest results (g).

| Growth Response | Group A | Group B | Group C |
|---|---|---|---|
| Measurement | 2 rows, North West | 2 rows, North Central | 2 rows, North East |
| Fresh weight (g) | 11,660 | 11,970 | 12,860 |
| Dry weight (g) | 3,400 | 3,540 | 3,420 |

Table 7. 1999 Crop profile results

| Crop | % Winter survival | Date of 1st flower | Vigour rating (0 = poor, 1= good) | Final Plant height | Harvest Date (where applicable) | Overall rating 0=poor; 1=good; 2=excel. | Notes |
|---|---|---|---|---|---|---|---|
| Goldenseal | 100% | May 14 | 0.5 | 8-10" | | 0.5 | |
| Fireweed | 100% | June 17, full bloom June 25 | 1.0 | 30 – 36" | August 3 | 2.0 | |
| Pyrethrum | 50% | July 2 | | | | | |
| Feverfew | 0% | | | | | | |
| Sweetgrass | | | 1.0 | | July 27 | | |
| American ginseng | 90% | July - sporatic | 1.0 | | Seed pods formed Aug. 17 | | Raven problems, picked out plants |
| Lingonberry | 100% | May 31 | 0 (very poor growth) | | Yield variable--- poor to excellent | | |
| Blueberry | 100% | June 10 | | | August 23 | | |
| Wild mint | Poor, but self-propagated inter-row plants more vigorous | July 12 | 1 (for those inter-row plants) | 12-15" | August 16 | 1.0 | |
| Labrador Tea | 90% | May 31 | 0 | 12" | August 16 | 1.0 but needs shade which was not provided | |
| Bloodroot | 88% | May 14 | 0 | 6 – 8" | August 16 | 0, root rot problems | |

Finally, a small test of strawberry crown production was established to determine if overwintering the mothers one year and harvesting in the second year would produce higher crown yields. The number of daughters produced by overwintered mothers was on average 26% higher than the first year crown production (Table 8). Thus, it may be worthwhile to investigate alternate harvesting methods where daughters are harvested while leaving mothers in the ground overwinter.

Table 8. Strawberry crown propagation from overwintered mother crowns

| Rep. | Mother number | Fall 1998 daughter # | Fall 1999 daughter # |
|---|---|---|---|
| 1 | 10 | 47 | 79 |
| 2 | 10 | 67 | 81 |
| 3 | 10 | 48 | 73 |
| 4 | 10 | 79 | 71 |
| Mean | 10 | 60.25 | 76 |

## References

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Kalt, W. and J. E. McDonald. 1996. Chemical composition of lowbush blueberry cultivars. J. Amer. Soc. Hort. Sci. 121(1):142-146.

# Towards Commercialization of the Cloudberry (*Rubus chamaemorus L.*) in Norway

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## INTRODUCTION

The cloudberry, *Rubus chamaemorus*, Rosaceae, is a small herbaceous bramble common to peat bogs in the northern hemisphere. The berry has a strong musky flavor, quite distinct from that of any of the other bramble crops, and is highly prized as a dessert berry in Scandinavia. Recently demand for the development of the cloudberry as a commercially viable crop has increased in northern Norway where many districts are struggling to maintain a viable economy.

## PLANT DESCRIPTION

### Distribution

The cloudberry is a circumpolar, subarctic species. It can be found as far north as 78°30' N in Svalbard, Norway and its distribution extends south to 44°N in New Hampshire, U.S.A. (Resvoll 1929). It is a common plant in northern Norway and is also found in the highland areas and mountains farther south.

### Morphology

The cloudberry is a dioecious perennial herb. The plant spreads mainly by means of an extensive rhizome system. Annual shoots consisting of from one to four lobed leaves may terminate in a single male or female flower. Insect pollination is required for fruit set to occur in most places though wind pollination may also contribute to fruit set in coastal windswept areas.

In Norway the cloudberry begins ripening in the end of July or early August. The berry, resembling a large amber raspberry, consists of from 5 to 25 drupelets. The cloudberry

contains from 50 to over 150 mg ascorbic acid per 100 gm fruit (Nordness and werenskiold 1951; Heller 1981). It is also rich in benzoic acid (Honkanen and Pyysalo 1976) and can therefore be easily stored for several weeks or longer under normal refrigeration. For these reasons the cloudberry was favored in the prevention of scurvy by Norwegian sailors and North American Eskimos (Faegri 1970; Heller 1981).

## COMMERCIALIZATION PROSPECTS

Although the cloudberry is a common plant throughout northern Norway, the Norwegians are unable to satisfy their domestic demand for the berry. In some years 200-300 tons of cloudberries are imported from Finland. The cloudberry harvest in the wild is highly unpredictable due to the unstable weather conditions prevailing in the beginning of June when the cloudberry flowers. Early frost in August may also destroy the crop in some years. In general, cloudberry yields from bog plants are very low, only averaging about 20 kg/ha. Domestication of the cloudberry would not only help fill the market demand for the berry but would also provide an attractive crop for use in boggy areas where little else of agricultural value can be grown. Several growers organizations have now been formed in Norway and a consultant has been employed at Holt Research Station, Tromsø, Norway (69°29'N) to study the commercialization potential of the crop and set forth research priorities.

### Progress

*Bog Management.* A number of bog management practices have been developed which can lead to greatly increased yields. Plowing furrows into a bog with a spacing of from 1-5 m leads to an increase in cloudberry proliferation and can reduce the incidence of spring freezes (Lid et al. 1961; Østgard 1964; Makinen and Oikarinen 1974; Rapp 1982). Fertilization of the bog with superphosphates or complete fertilizers (300 kg/ha) can increase yields per hectare by an average of 50 kg when the fertilizer is placed at a depth of 20-25cm (Rapp 1989). Fertilizers applied to the surface of the bog or at greater depths tend to benefit other bog species at the expense of the cloudberry. In windswept areas short fences may be useful in settling the snow in the winter to delay the blossoming period and therefore avoid spring frost injury. The use of windrows also leads to an increase in the activity of pollinating insects and has increased yields in several studies (Østgard 1964).

*Genotype Improvement.* A prerequisite for the success of any of these bog management practices is the existance of a good stand of female (fruit bearing) plants. In most cloudberry producing bogs, less than 25% of the flowering shoots are female (Lid et al. 1967). Even among seedling populations there is an overabundance of male plants (Rapp 1987). Current research is therefore aimed at the breeding of higher yielding female or hermaphrodite cultivars and the development of efficient propagation methods.

The development of cloudberry cultivars is well underway at Holt Research Station in northern Norway. Hundreds of seedlings from several different environments have been screened for high flower production and large berry size (Rapp 1988). Further performance evaluations have been made on promising selections in square meter plots where their ability to spread and become rapidly established can also be assessed. From these, two superior female clones and two superior male clones have now been selected for cultivar release.

The development of hermaphrodite cultivars is an important goal in the domestication of the cloudberry. Occasionally hermaphrodite flowers can be found in the wild. Several plants bearing such flowers have been collected for evaluation. Unfortunately sex expression in these plants varies from year to year and also from flower to flower within a clone. Plants with hermaphroditic tendencies are currently being used as parents in the cloudberry breeding program in an attempt to develop stable hermaphrodite cloudberry cultivars.

Several crosses between cloudberry and other *Rubus* species including a hybrid blackberry, red raspberry clones and several asiatic ideobats have produced plants with overall general *chamaemorus* morphology (thornless, herbaceous, non-elongating) however leaf pattern is definately hybrid. The cloudberry X blackberry cross is much more vigorous than other hybrids and cloudberries.

Rapid and good seed germination is important to the success of a cloudberry breeding program. Normally cloudberry seed require 6-8 months cold stratification before germinating and germination rates are often well below 50% (Rantala 1976). By removing the endocarp and seed coat from fresh cloudberry seed we have obtained in vitro germination rates of 75-85% four weeks after culture initiation.

*Plant Propagation*. The cloudberry is difficult to propagate relative to other bramble species. Large turfs must be dug when collecting selections from the wild to ensure transplant survival. Further propagation of the selection can be made through the use of rhizome cuttings. The success rate with rhizome cuttings has been greatly improved by increasing the length of the cutting from ca 7 cm to 15-20 cm. The best results have been obtained when the rhizome cuttings are taken in May or August (Rapp 1986). Although the cloudberry proliferates readily in tissue culture, explant rooting remains a major problem.

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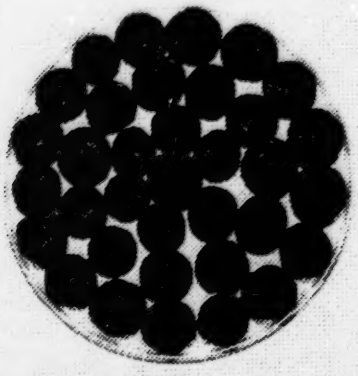
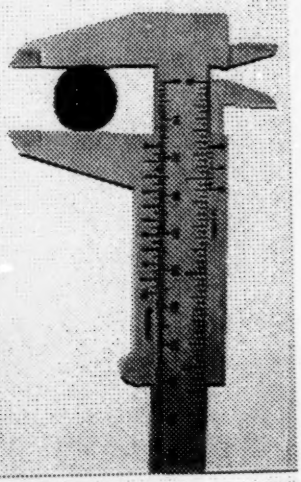
Fig. A

Blueberries

A



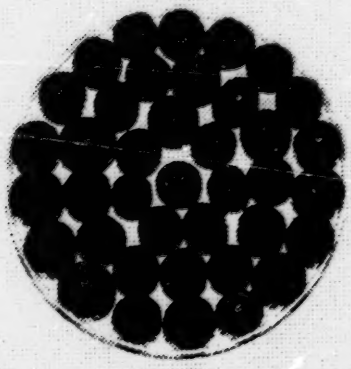


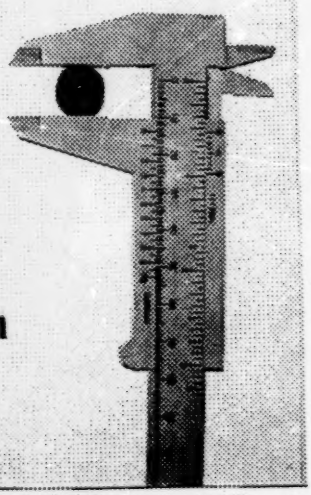
La Ronge, Saskatchewan
August 24, 1999

Fig. B

Blueberries

B





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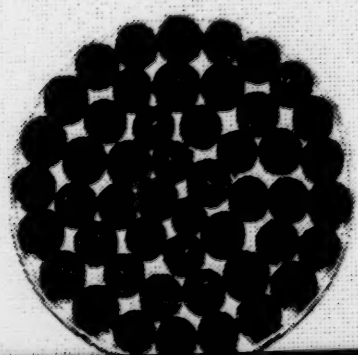
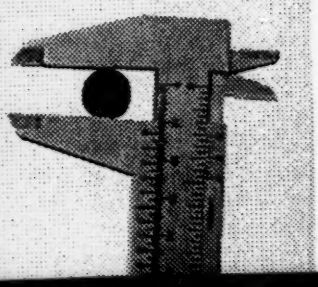
August 24, 1999

Fig. C

Blueberries

C

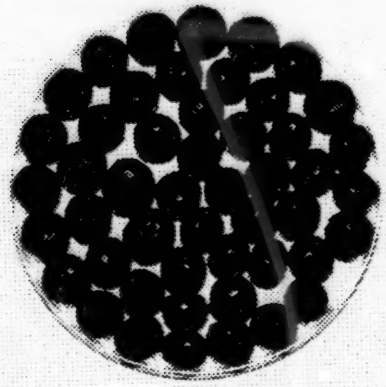


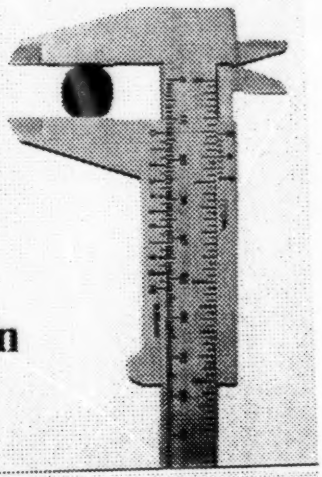


Blueberries

Fig. D

D



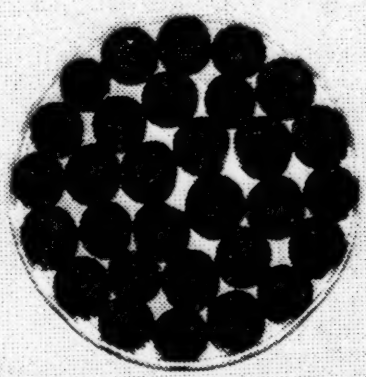


La Ronge, Saskatchewan
August 24, 1999

Blueberries

Fig. E

E

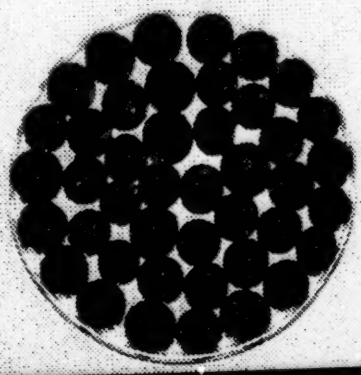


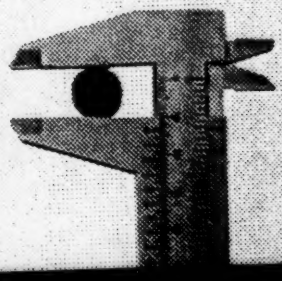
La Ronge, Saskatchewan
August 24, 1999

Blueberries

Fig. F

F





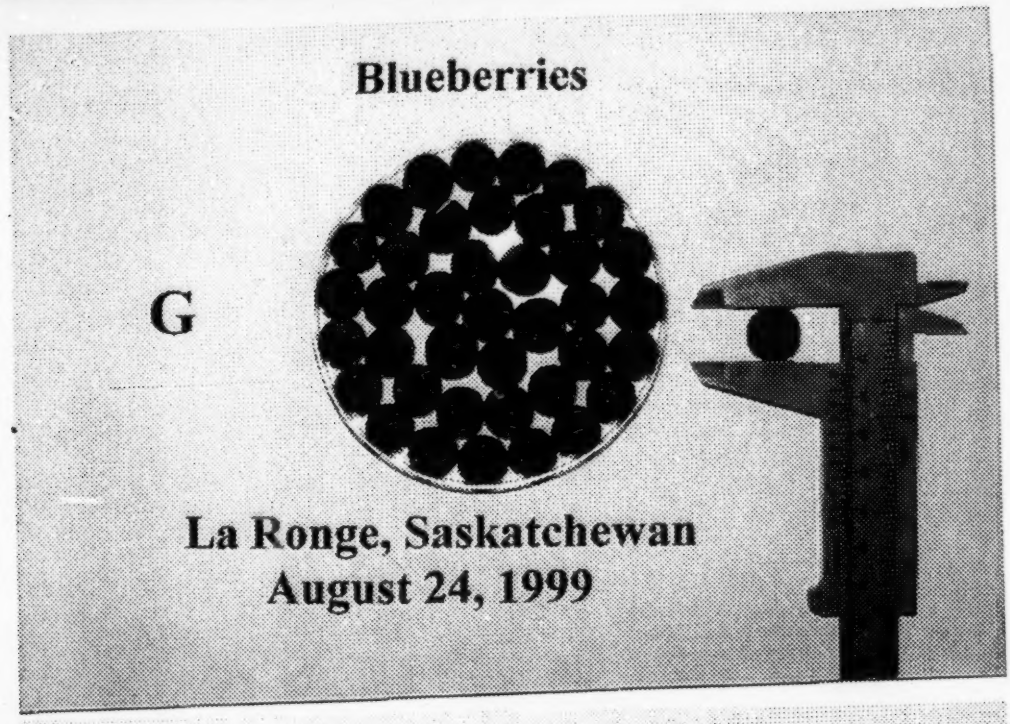

Blueberries
G
La Ronge, Saskatchewan
August 24, 1999

Fig. G

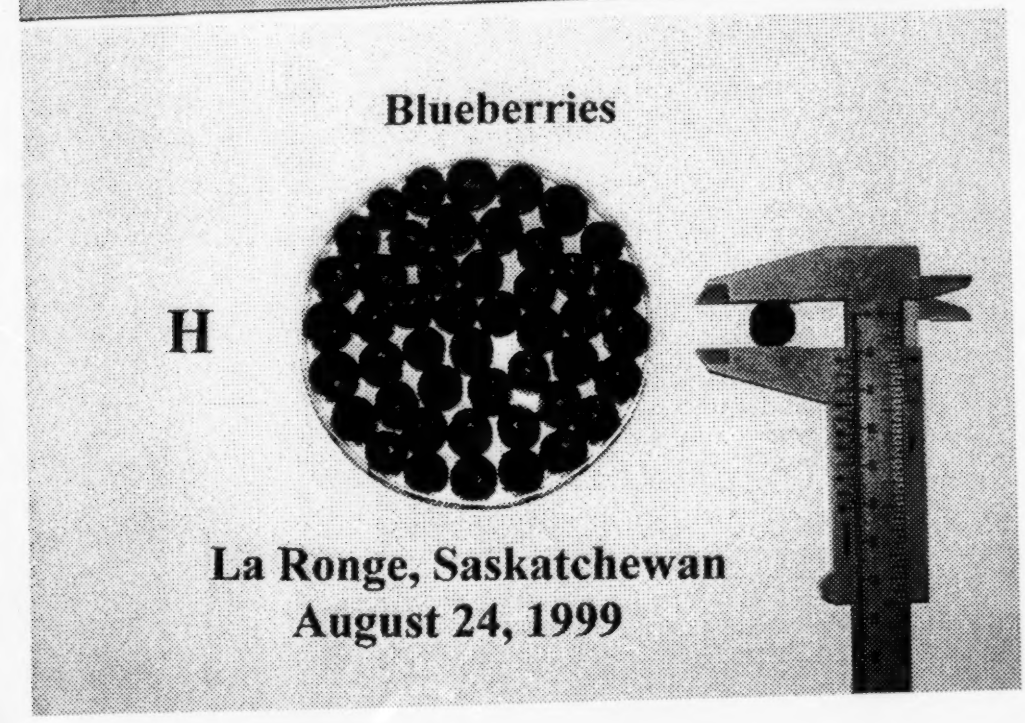

Blueberries
H
La Ronge, Saskatchewan
August 24, 1999

Fig. H

Fig. 1 BLUEBERRY Selections A - H, Mean 20 Berry (Fresh Weight, g) 1999

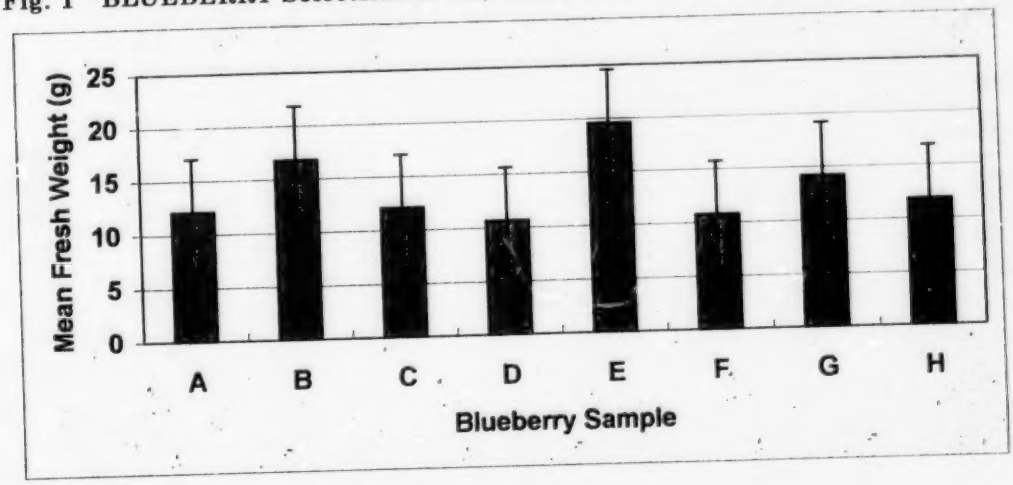



Fig. 2 BLUEBERRY Selections A - H, Mean 20 Berry (Dry Weight, g) 1999

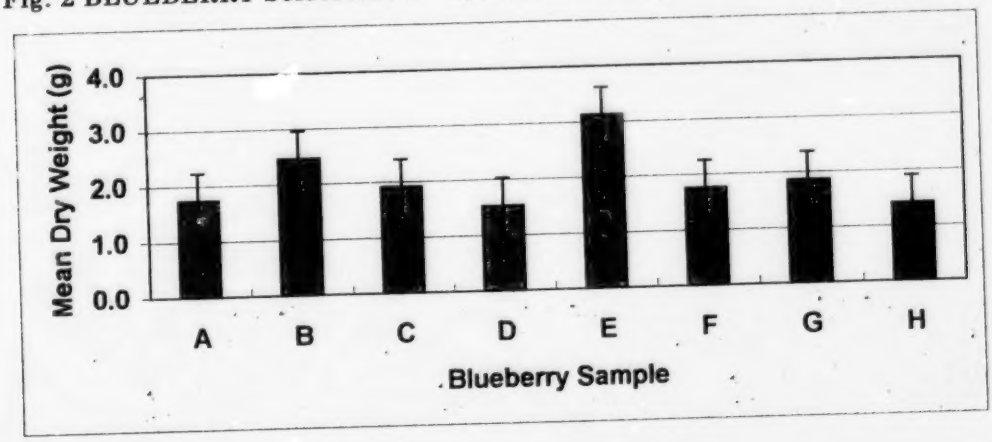



Fig. 3 BLUEBERRY Selections A - H, Mean Percent Water Content (g) 1999

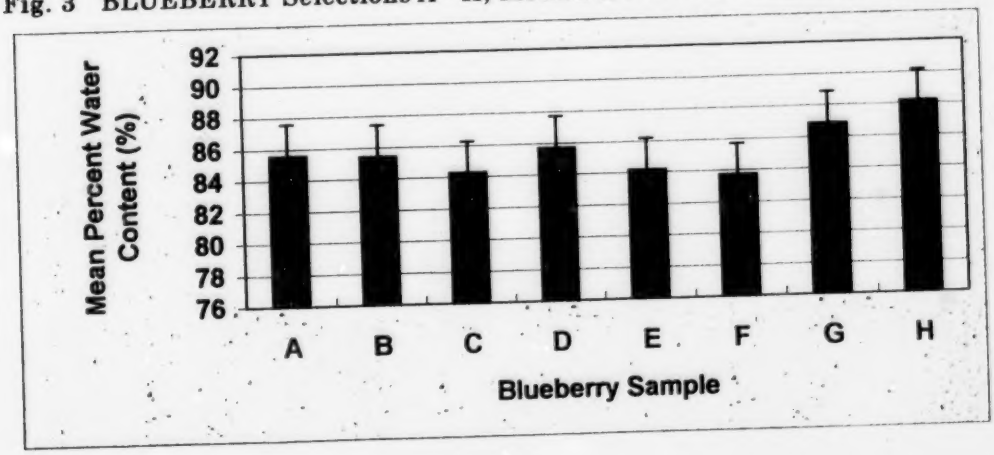


Fig. 4. Mean pH Blueberry Samples A – H, 1999

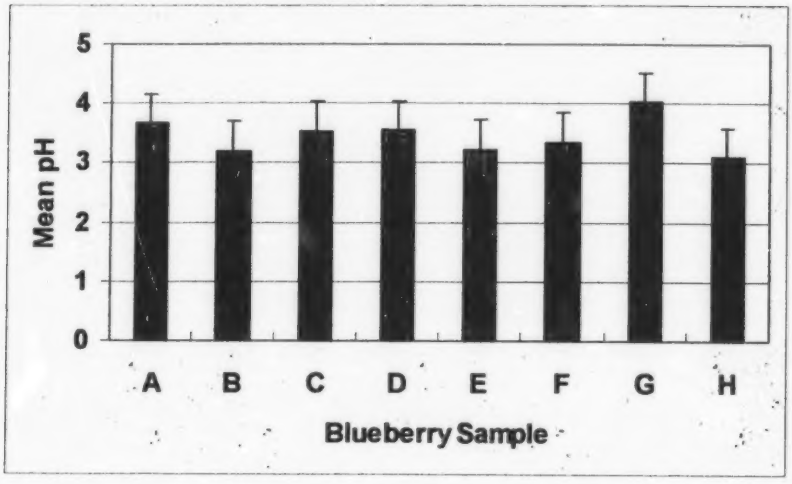



Fig. 5. Mean Brix, Blueberry Samples A – H

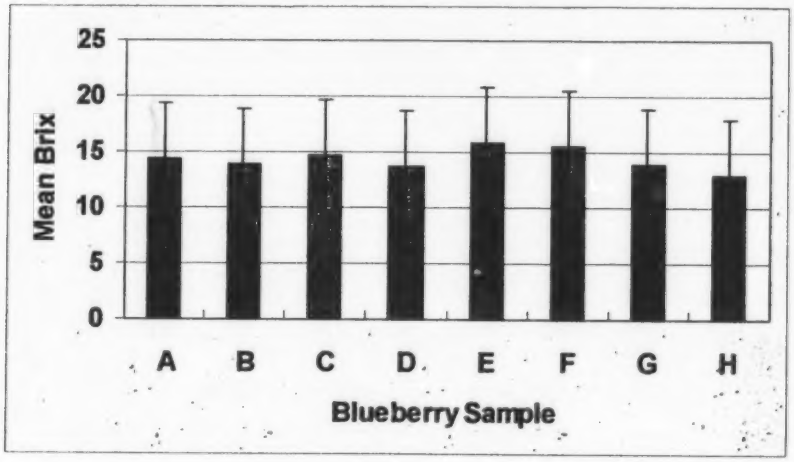


Fig. 6. Blueberry Colour, Mean L-Value, 1999

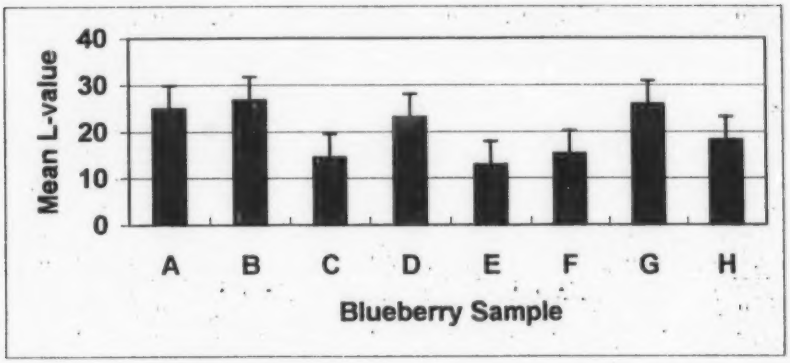



Fig. 7. Blueberry Colour, Mean A-Value, 1999

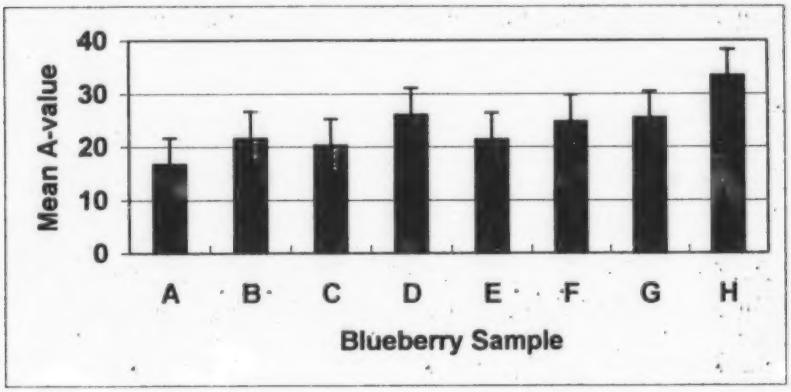



Fig. 8. Blueberry Colour, Mean B-Value, 1999

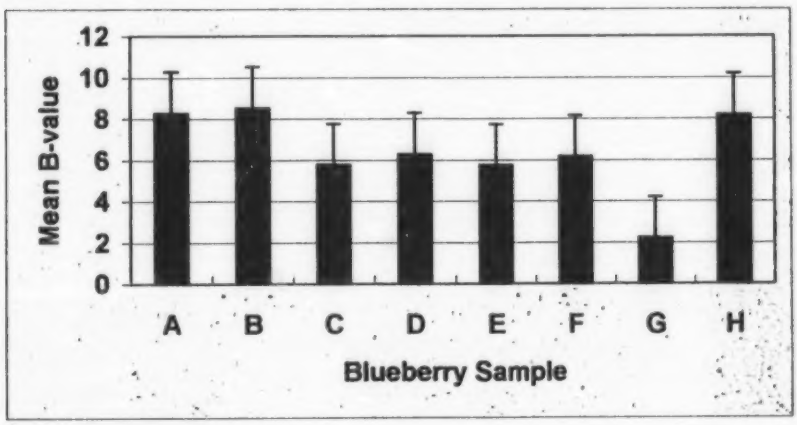


Fig. 9. Blueberry 20 Berry (Fresh Weight, g), Samples B, E, F, H, 2000

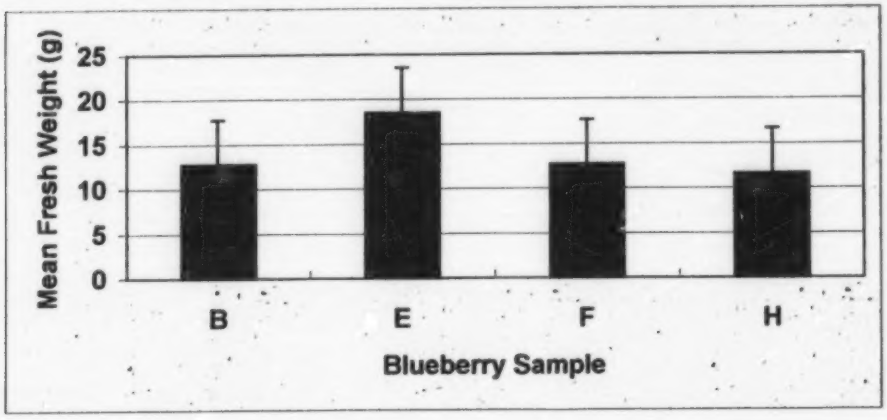



Fig. 10. Blueberry 20 Berry (Dry Weight, g), Samples B, E, F, H, 2000

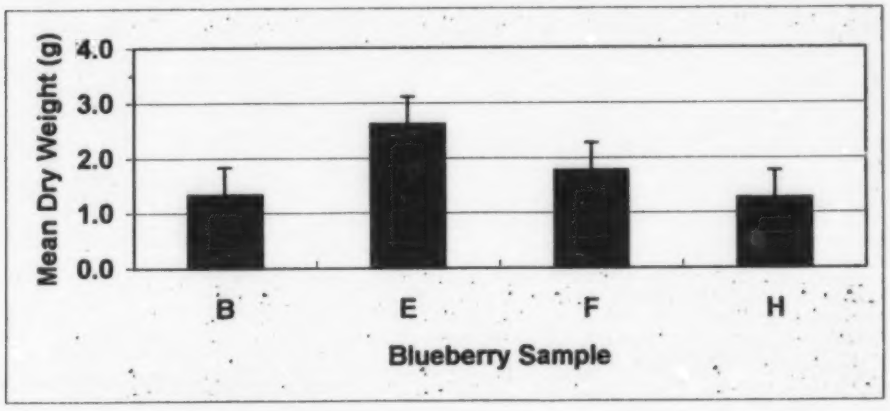



Fig. 11. Blueberry Percent Water Content, Samples B, E, F, H, 2000

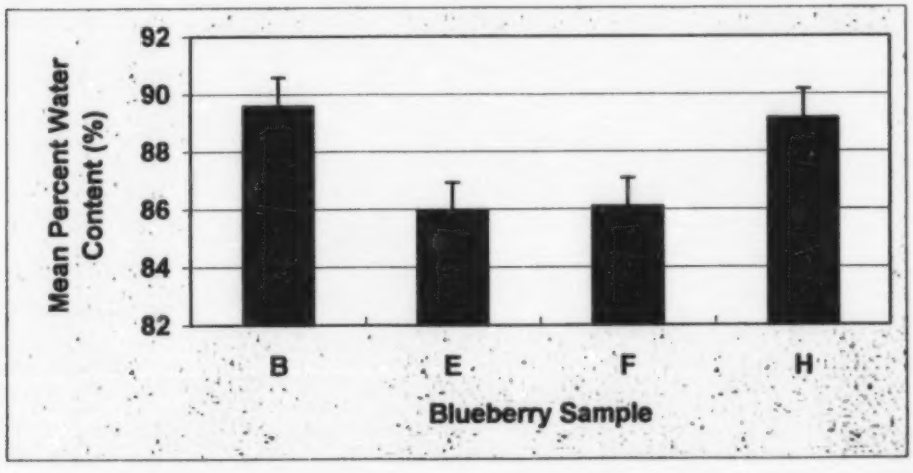


Fig. 12. Mean pH, Blueberry Samples A-H, 2000

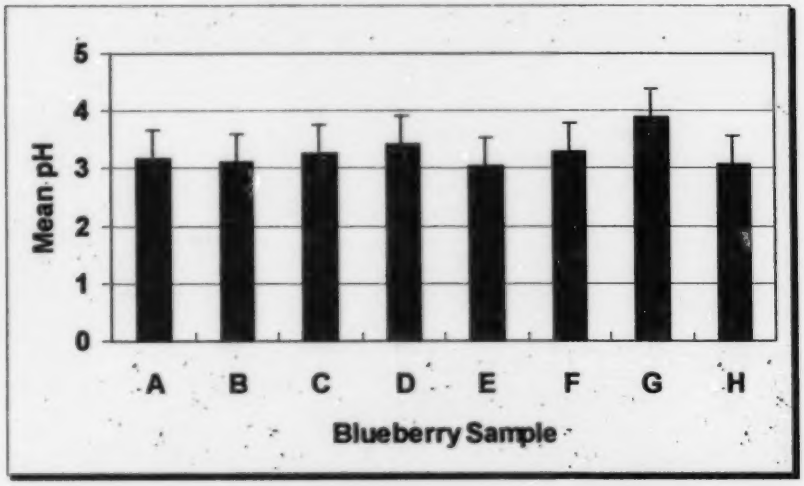



Fig. 13. Mean Brix, Blueberry Samples A-H, 2000

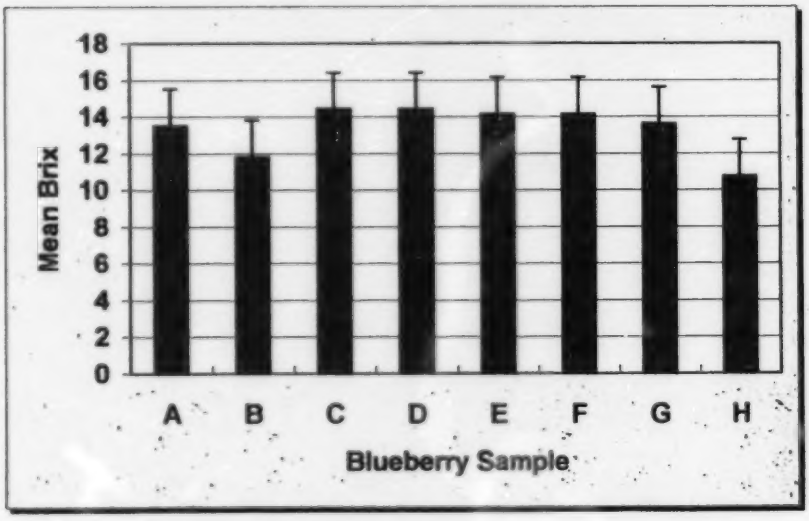


Fig. 14. Blueberry Colour, L-Value, Samples A-H, 2000

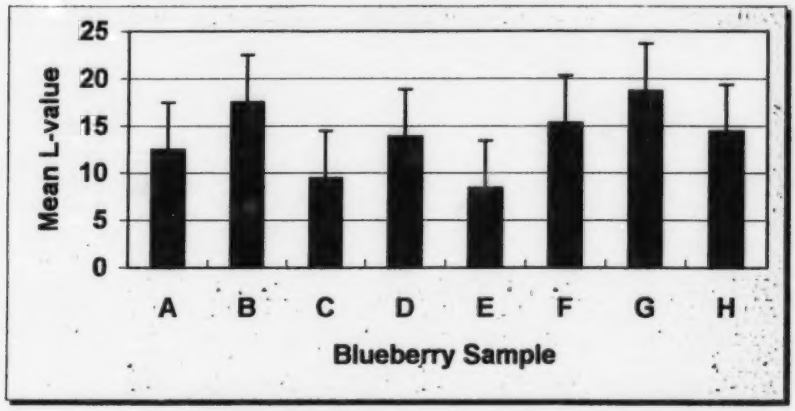



Fig. 15 Blueberry Colour, A-Value, Samples A-H, 2000

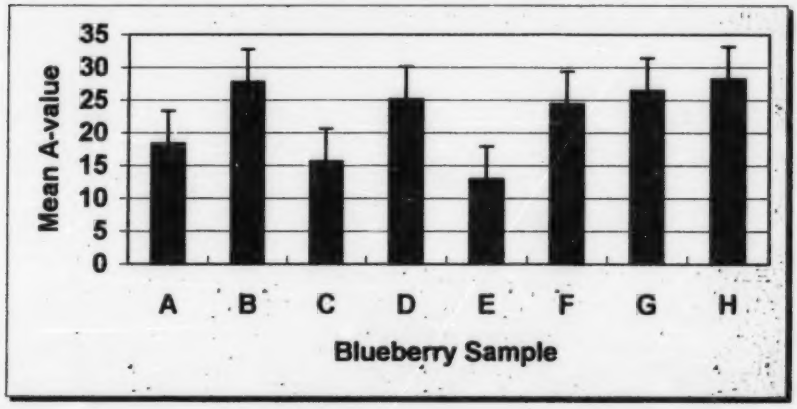
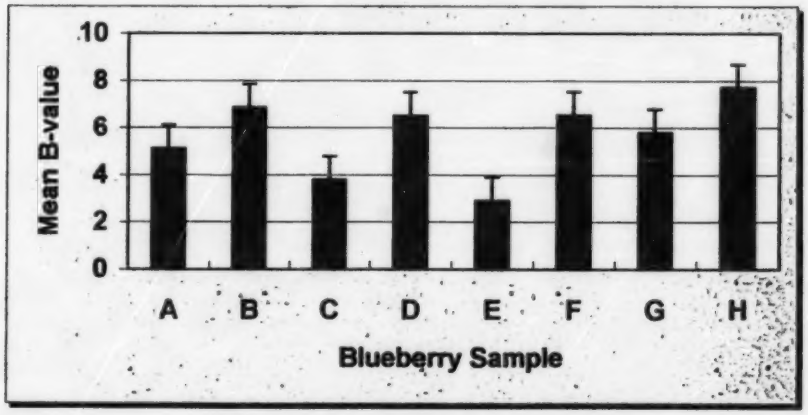



Fig. 16 Blueberry Colour, B-Value, Samples A-H, 2000



**Personnel**

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- Corey Walcer (assistant)
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